

Design of a Fragment Generator

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There is much continuing interest in the defense community about fragments hitting conventional munitions. This includes conventional munitions in the field and those in storage that may be bombarded with fragments generated from another munition detonating either intentionally or unintentionally. This can also include the possibility of defeating a munition that has already been deployed. The conventional munitions can encounter a single fragment or several fragments. This paper represents the first stages of an experimental and theoretical study recently undertaken to investigate these scenarios.

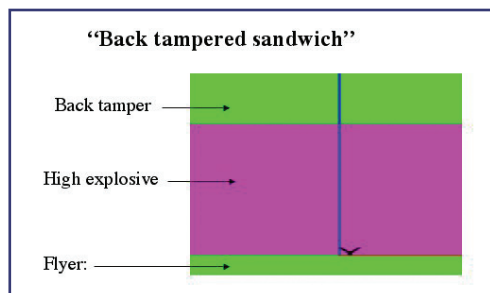
We first need to design the mechanism that will “throw” the fragments. Later, these fragments will be directed at targets, or acceptors, and the resulting impacts will be studied for various scenarios including prompt initiation, delayed initiation, and preconditioning of the acceptor relative to a

subsequent impact. The fragment generator needs to be compact enough to facilitate directing it at the acceptor from various directions and it needs to be able to throw the fragment over a wide range of speeds. The fragments generated should be of reproducible shape and preferably experience limited plastic deformation during the generation process. The design also needs to be simple and use widely available materials in order to be manufactured quickly, in large numbers, and in a standard, uniform way at a variety of sites.

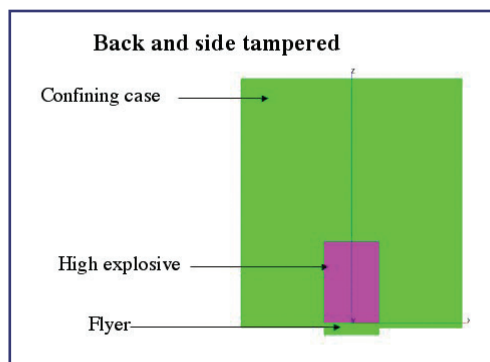
We investigated a variety of potential designs by conducting finite element analysis simulations using the code EPIC. Figures 1–4 depict four designs we investigated. All of the designs are axially symmetric. The first is the “back tampered sandwich.” Tamper refers to the back metal plate, which provides inertial confinement of the expanding gases, directing them down and providing extra push to the fragment. In Figs. 1–3 green and red depicts metal and pink the high explosive and all of the designs generate fragments moving down. Using an analysis pioneered by Gurney [1] we were able to conclude that the back-tampered sandwich could not attain fragment speed necessary for this study.

The next design, the back and side tampered sandwich is shown in Fig. 2. While Gurney’s analysis predicts that this configuration could produce adequate velocities for this study, simulations with EPIC showed that no available steel could produce adequate confinement to generate the necessary speeds, so this configuration was abandoned.

In Fig. 3 we illustrate the Forest Flyer configuration, first created at Los Alamos National Laboratory by C. Forest [2]. In this case the EPIC simulations indicated that the design could reach the desired speeds, but that the damage to the fragment was quite extensive. We tried a variety of modifications to the design, but whenever we attained the desired speed the damage was too extensive. At lower speeds, however, the damage was much less severe.



*Figure 1—
The back-tampered
sandwich design.*



*Figure 2—
The back- and side-
tampered design.*

Finally, we modified the design of M. Held [3] to accommodate our desired fragment configurations. In this design as seen in Fig. 4 there is no back or side tamper, but there is an axial confinement to the fragment which also serves to direct the expanding gases to further push the fragment. The axial confining ring also serves to suppress damage in the fragment and the 10-degree angle ensures that the remnants from the ring are not directed towards the acceptor. We found that we could attain the desired speeds with this configuration and that there was damage to the fragment but not to the extent observed with the Forest Flyer. Figure 5 shows the simulated flyer after it has been fully accelerated by the high explosive. The colors represent the amount of plastic flow experienced by the flyer, and the lines are contours. As can be seen there is little deformation except at the edges of the flyer, which was considered to be acceptable.

We passed on our designs of the fragment generator to experimentalists in Dynamic Experimentation Division where they will build and test the generator. Unfortunately the recent laboratory stand down has delayed that aspect of the study. In the meantime we will continue to study fragments impacting acceptors.

- [1] R.W. Gurney, "The Initial Velocities of Fragments from Bombs, Shells, and Grenades," Army Ballistic Research Laboratory Report BRL 405.
- [2] C.A. Forest, et al., *11th International Det. Symposium*, Snowmass Village, CO, 332 (1998).
- [3] M. Held, *Propellants, Explosives, Pyrotechnics* 25, 8 (2000).

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Acknowledgements

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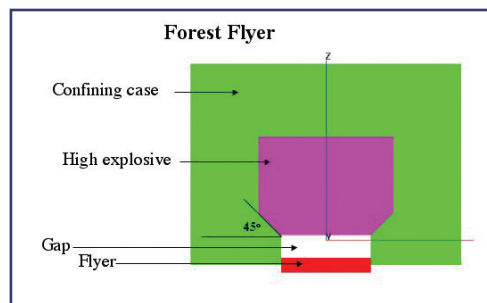


Figure 3—
The "Forest Flyer"
design.

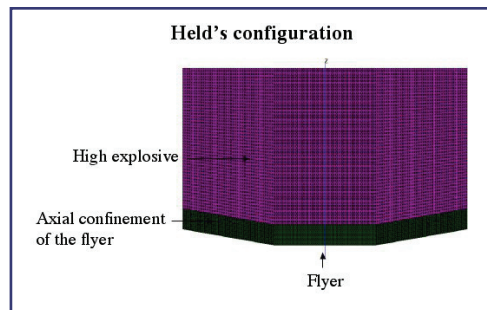


Figure 4—
The M. Held design.

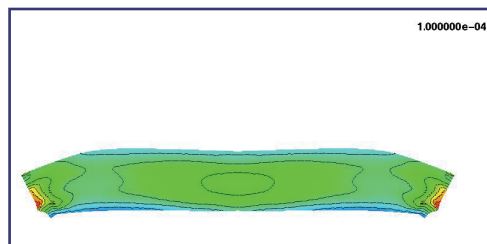


Figure 5—
An image of the flyer af-
ter being accelerated by
the thrower. The colors
represent the amount of
plastic deformation.